SPECIFICATION

TO WHOM IT MAY CONCERN:

Be it known that we, Michael Clement Whitfield, Jerome Michel Vialle, and Remy Gauguey, with residence and citizenship listed below, have invented the inventions described in the following specification entitled:

PACKET LENGTH INDICATION FOR A FACSIMILE SYSTEM

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PACKET LENGTH INDICATION FOR A FACSIMILE SYSTEM

Background of the Invention

1. Field of the Invention

The invention is related to the field of communication systems, and in particular, to a facsimile system that transfers facsimiles in packets that indicate individual packet length.

2. Statement of the Problem

Facsimile machines transfer documents over telephone lines and have become an important business tool. To send a facsimile, the sending facsimile machine scans the document into digital data and encodes the data to remove redundant data. The sending facsimile machine generates a modem call to the receiving facsimile machine and the two facsimile machines exchange tones and flags to set-up the transfer. The sending facsimile machine then converts the encoded digital data into an analog signal that it transfers over the telephone lines to the receiving facsimile machine. The receiving facsimile machine converts the analog signal back into the digital data and prints the document based on the digital data. One current standard for telephony facsimile transmission is International Telecommunication Union (ITU) Recommendation T.30

Facsimile transmissions over local telephone lines are relatively inexpensive because local telephone calls are typically based on a flat rate fee. Transmission costs are essentially the same even if a large amount of facsimile transmissions are

sent. Unfortunately, many facsimile transmissions require the use of long distance telephone lines that add additional expense, especially if international telephone lines are used.

One solution to this problem uses the Internet for a segment of the facsimile transmission. The sending facsimile machine transfers the facsimile transmission to an emitting gateway using a local telephone call. The emitting gateway receives the facsimile transmission in the same manner as a receiving facsimile machine. The emitting gateway then converts the facsimile transmission into Internet Protocol (IP) packets and transfers the IP packets over the Internet to a receiving gateway near the receiving facsimile machine. The receiving gateway converts the IP packets back into a facsimile transmission and transfers the facsimile transmission to the receiving facsimile machine using a local telephone call. The receiving gateway transfers the facsimile transmission in the same manner as a sending facsimile machine. One current standard for IP facsimile transmission is International Telecommunication Union (ITU) Recommendation T.38.

The Transmission Control Protocol (TCP) is often used for IP communications because TCP includes error control that IP does not. TCP can recover from lost, duplicated, or corrupted packets as follows. An application layer transfers a message block to the TCP layer. The TCP layer breaks the message block into segments with sequence numbers. The TCP layer transfers the segments in TCP packets to the IP layer. The IP layer encapsulates the TCP packets within IP packets and transfers the IP packets over the Internet to another IP layer. The receiving IP layer strips off the IP encapsulation and transfers the resulting TCP packets to a receiving TCP layer.

The receiving TCP layer rebuilds the message block from the segments in the TCP packets. The receiving TCP layer returns an acknowledgment (ACK) to the sending TCP layer if it correctly received message block. The sending TCP layer re-transmits the message block if it is not properly acknowledged.

Because of the error control, TCP is useful for IP facsimile transmissions based on ITU T.38. An application layer based on ITU T.38 transfers application packets to the TCP layer. The TCP layer places the application packets into segments and transfers the resulting TCP packets. If an application packet is smaller than a segment, then there is room in the end of the segment to start the next application packet. Per TCP standards, the next application packet may be started in that segment and finished in the next segment.

The overlap of an application packet across segment boundaries may lose the application packet boundaries. The loss of application packet boundaries poses a serious problem to the receiving gateway because it cannot readily determine where packets begin and end. Even if the TCP layer is forced to send one application packet per TCP packet during normal transmission, the problem remains if there is a TCP re-transmit due to a lost or defective segment. This is because the TCP layer can re-transmit multiple application packets within the same segment despite the forcing rule on normal transmissions.

Summary of the Solution

The invention solves the above problem with a facsimile system that indicates individual application packet lengths. A receiving gateway can re-establish

application packet boundaries lost during TCP/IP transfer by using the packet lengths. This solution is especially effective when there is a TCP re-transmit due to a lost or defective segment.

The invention includes systems and methods for transferring a facsimile using a Transmission Control Protocol/Internet Protocol (TCP/IP) network. A facsimile system comprises a first communication processing system and a second communication processing system. The first communication processing system converts the facsimile into application packets that indicate individual application packet lengths. The first communication processing system then converts the application packets into TCP/IP packets and transfers the TCP/IP packets to the TCP/IP network. The second communication processing system receives the transferred TCP/IP packets from the TCP/IP network and converts the transferred TCP/IP packets into transferred application packets. The second communication processing system converts the transferred application packets into the facsimile using the individual application packet lengths.

Description of the Drawings

FIG. 1 is a block diagram that illustrates a facsimile system and its operating environment in an example of the invention.

FIG. 2 is a block diagram that illustrates a communication processing system in an example of the invention.

FIG. 3 is a logical diagram that illustrates a TCP/IP packet in an example of the invention.

A particular reference number represents the same element on all figures.

Detailed Description

Facsimile System and Operating Environment -- FIG. 1

FIG. 1 depicts a specific example of a facsimile system in accord with the present invention. Those skilled in the art will appreciate numerous variations from this example that do not depart from the scope of the invention. Those skilled in the art will appreciate that various features described below could be combined to form multiple variations of the invention. Those skilled in the art will appreciate that some conventional aspects of FIG. 1 have been simplified or omitted for clarity.

FIG. 1 is a block diagram that illustrates facsimile system 100 and its operating environment in an example of the invention. Facsimile system 100 comprises communication processing systems 121 and 122 that are each connected to TCP/IP network 130. TCP/IP network 130 could be the Internet, although other TCP/IP networks are also within the scope of the invention. Facsimile machine 101 is connected to telephone network 111 which is connected to communication processing system 121. Facsimile machine 102 is connected to telephone network 112 which is connected to communication processing system 122.

Facsimile machine 101 transfers a facsimile in real time to facsimile machine 102 over facsimile system 100 and telephone networks 111-112 as follows. Facsimile machine 101 transfers the facsimile to communications processing system 121 through telephone network 111. Communication processing system 121 converts the facsimile into application packets and converts the application packets

into TCP/IP packets. Communication processing system 121 transfers the TCP/IP packets to TCP/IP network 130. TCP/IP network 130 transfers the TCP/IP packets to communication processing system 122. Communication processing system 122 converts the transferred TCP/IP packets into transferred application packets and converts the transferred application packets into the facsimile. Communication processing system 122 transfers the facsimile to facsimile machine 102 through telephone network 112.

The boundaries for the transferred application packets are lost during TCP/IP transfer. In a distinct advance in the art, communication processing system 121 indicates individual application packet lengths in the application packets, and communication processing system 122 uses these individual application packet lengths when converting the transferred application packets into the facsimile. A facsimile transmission in the opposite direction from facsimile machine 102 to facsimile machine 101 could occur in a reciprocal manner. Aside from the modifications to communication processing systems 121 and 122 that are required to use application packet lengths, the configuration and operation of the components on FIG. 1 could be conventional.

Communication Processing System – FIGS. 2-3

FIGS. 2-3 depict a specific example of a communication processing system in accord with the present invention. Those skilled in the art will appreciate numerous variations from this example that do not depart from the scope of the invention. Those skilled in the art will also appreciate that various features described below

could be combined with the above-described embodiment to form multiple variations of the invention. Those skilled in the art will appreciate that some conventional aspects of FIGS. 2-3 have been simplified or omitted for clarity.

FIG. 2 is a block diagram that illustrates communication processing system 121 in an example of the invention. Communication processing system 122 could be similar. Communication processing system comprises application processing system 222, interface 223, and TCP/IP processing system 224. Interface 223 is coupled to application processing system 222 and TCP/IP processing system 224. Application processing system 222 is connected to telephone network 111. TCP/IP processing system 224 is connected to TCP/IP network 130.

Application processing system 222 is configured to interwork facsimile transmissions between telephone network 111 and TCP/IP processing system 224. In some embodiments of the invention, application processing system 222 operates based on ITU Recommendations T.30 and T.38 as modified by the invention. Interface 223 and TCP/IP processing system 224 could be conventional.

Application processing system 222 handles a facsimile call from telephone network 111 as follows. To set-up the transmission, application processing system 222 exchanges tones and data with telephone network 111 and exchanges corresponding application packets with TCP/IP processing system 224 through interface 223. Once the transmission is set-up, application processing system 222 receives the facsimile from telephone network 111, converts the facsimile into application packets, and transfers the application packets to TCP/IP processing system 224 through interface 223. Application processing system 222 determines

the length of each application packet and indicates the length in a field in the respective application packet. The length field could be a two-byte field. TCP/IP processing system 224 exchanges application packets with application processing system, converts between the application packets and TCP/IP packets, and exchanges the TCP/IP packets with TCP/IP network 130.

Before packet transfer over TCP/IP network 130, application processing system 222 receives destination information for the facsimile. The destination information could be generated by facsimile machine 101 or telephone network 111 and could include a called number, an IP address, or some other routing code. Application processing system 222 processes the destination information to identify the IP address and the called number for the facsimile. The called number may not be needed if the destination facsimile machine on TCP/IP network 130. Application processing system 222 indicates the IP address to the TCP/IP processing system 224, which places the IP address in the TCP/IP packets. If required, application processing system 222 places the called number in an application packet for subsequent use on the other side of TCP/IP network 130.

FIG. 3 is a logical diagram that illustrates a TCP/IP packet 350 in an example of the invention. TCP/IP packet 350 comprises IP header 331 and IP payload 332. IP payload 332 includes TCP header 333 and TCP payload 334. TCP payload includes application packet 340. Application packet 340 carries the facsimile. application packet 340 includes length field 341 that indicates the length of application packet 340. Thus, length field 341 defines the boundaries of application

packet 340 – application packet 340 starts just after length field 341 and continues for the stated packet length.

Referring to FIG. 2, application processing system 222 handles a facsimile transmission from TCP/IP network 130. as follows. TCP/IP processing system 224 exchanges TCP/IP packets with TCP/IP network 130 and converts between the TCP/IP packets and application packets. It should be noted that the packet boundaries for these application packets may have been lost, so the application packets transferred to application processing system 222 may not be in discreet packets.

To set-up the transmission, application processing system 222 exchanges application packets with TCP/IP processing system 224 through interface 223 and exchanges corresponding tones and data with telephone network 111. Application processing system 222 receives the called number for the facsimile in one of the application packets. Once the transmission is set-up, the application processing system 222 then receives application packets from TCP/IP processing system 224, converts the application packets into the facsimile, and transfers the facsimile to telephone network 111 using the called number.

The application packets that application processing system 222 receives from TCP/IP processing system 224 may not have adequate packet boundaries. Application processing system 222 uses the length from the length field of each application packet to locate application packet boundaries that may have been lost in the TCP/IP transfer. This is especially important if a TCP re-transmit occurs due to a lost or defective TCP segment.

The above-described processing systems include storage media that store instructions and processors that retrieve and execute the instructions. Some examples of instructions are software, program code, and firmware. Some examples of storage media are memory devices, tape, disks, integrated circuits, and servers. The instructions are operational when executed by a processor to direct the processor to operate in accord with the invention. The term "processor" refers to a single processing device or a group of inter-operational processing devices. Some examples of processors are computers, integrated circuits, and logic circuitry. Those skilled in the art are familiar with instructions, processors, and storage media.

Those skilled in the art will appreciate variations of the above-described embodiments that fall within the scope of the invention. As a result, the invention is not limited to the specific examples and illustrations discussed above, but only by the following claims and their equivalents.

What is claimed is: